# What Metrics and Measurements Are Needed to Monitor Progress?

# Context

- “Our vision of the future is for carbon-neutral growth in the medium term, and zero carbon emissions technology development within 50 years.” - IATA Director, Aviation Environment

# Context

- “Aviation and the Environment,” 2004:
  - Move forward with existing metrics, but plan for specific actions for their improvement
  - Measure progress based upon specific health and welfare endpoints
  - Supplemental metrics involving quantities of pollutant or efficiency metrics can relate the national goals to policy or regulatory benchmarks
  - For areas of uncertainty, the metric employed should be the uncertainty in assessing impacts

# What are the Overall Goals?

- Program-level goals will determine the correct parameters to measure and track
  - Global goal, for example:  limit aviation impact to today's level
  - Regional goal, for example:  contain noise to airport boundary; limit NOx and particulates
- Overall goals need to be decomposed to system components, for example:
  - Propulsion
    - System efficiency
    - Fuel/energy technology
  - Airframe
    - Weight
    - Drag
  - Operational
    - Airline operations
    - Air traffic management
    - Origin-to-destination efficiency

# Measurements lead to metrics

- Characteristics of desirable metrics
  - Easily and economically measured
  - Accurate and precise
  - Linked to something that matters, e.g., fuel burn links to $CO_2$, noise measurements link directly to airport metrics
- Metrics should include life cycle impacts of new systems, e.g., biofuel production systems

# Bottom Line

- We don't really know, but…
- Noise is readily measured and will certainly be one of the overall metrics
- Fuel burn can be correlated to many parameters of interest ($CO_2$, $NO_x$, particulates)
  - Fuel burn as a function along trajectories may provide a rich picture of where the pollutants are going